Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5088

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (2):** 1275-1280 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Integrated Weed Management Practices on Yield and Economics of Pigeonpea (*Cajanus cajan* (L.) Millsp.)

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Received: 29.06.2017 | Revised: 25.07.2017 | Accepted: 1.08.2017

ABSTRACT

A field experiment was conducted during kharif (rainy) season of 2013 at Regional Agricultural Research Station, Lam, Guntur, India in randomized block design with three replications to study the effect of integrated weed management practices on yield and economics of pigeonpea. The weed free treatment significantly decreased the weed density, dry weight of weeds and also increased in weed control efficiency compared with weedy check. Integration of intercultivation at 50 days after sowing (DAS) with pendimethalin @0.75 kg a.i.ha^{-1} as pre-emergence (PE) or imazethapyr @ 100 g a.i.ha^{-1} as post-emergence (POE) at 10-15 DAS or pendimethalin@0.75 kg a.i. ha^{-1} as PE followed by imazethapyr @ 100 g a.i. ha^{-1} as POE at 10-15 DAS proved effective in reducing total weed density and dry weights of weeds and also increased in weed control efficiency compared with weedy check. The maximum growth parameters, yield components, grain yield and B:C ratio recorded under weed free situation were comparable with that obtained from integration of herbicides, pendimethalin @0.75 kg a.i. ha^{-1} PE and imazethapyr @ 100 g a.i.ha^{-1} POE at 15-20 DAS with intercultivation at 50 DAS.

Key words: *Pigeonpea, IWM, Weeds, Intercultivation, B:C ratio.*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] commonly known as red gram, *tur* or *arhar* is the fifth prominent legume crop in the world. India, Myammar, Malawi, Kenya, Uganda and Tanzania are the major pigeonpea producing countries. It has been recognized as a valuable source of protein for the vegetarians in their daily diet. In India, pigeonpea is second most important pulse crop of India which has diversified uses as food, feed, fodder and fuel, next to Chickpea producing 3.29 million tonnes annually from 3.88 million ha. The Indian sub continent alone contributes nearly 92 per cent of the total pigeonpea production in the world. Although India leads the world both in area and production of pigeonpea, its productivity is lower (697 kg ha^{-1}) than the world average (775 kg ha^{-1})[3].

In India, pigeonpea is grown in *kharif* season. Slow initial growth and sowing at wider spacing, severe infestation of weeds was observed in pigeonpea due to rainy season which results in low grain yield. Crop yield losses due to weeds were estimated to a range of 55 to 60% has been reported in pigeonpea[6].

Cite this article: Venkata Rao, P., Subbarami Reddy, A., Rajamani, S., Sreekanth, M. and Ramana, M.V., Effect of Integrated Weed Management Practices on Yield and Economics of Pigeonpea (*Cajanus cajan* (L.) Millsp.), *Int. J. Pure App. Biosci.* **6(2):** 1275-1280 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5088

So it is very necessary to find out effective weed control techniques using herbicides. The predominant method of weed control by mechanical hoeing and manual weeding over extensive scale is found to decline because of shift of agricultural labourers to industries for better and assured wages. In pigeonpea, initial six-seven weeks period (42-49 days) is the critical period of crop-weed competition. Therefore, weeds must be controlled during this period for realizing higher grain yields. Pre-emergence application of herbicides may help in checking weed growth during this period. Pendimethalin, as pre-emergence herbicide, has been found effective in controlling weeds and improving pigeonpea yield[10]. However, it is effective only up to one month and thereafter weeds may pose a problem again. Therefore, the use of herbicides alone or in combination with other weed control techniques reduces the crop weed competition and the risk of weeds growing unchecked in period of adverse weather. The integrated weed management approach is advantageous because one technique rarely achieve complete long and effective control of all weeds during crop season. Integrated use of pendimethalin with hand weeding or ridging may help in achieving season long weed control. Integrated weed management provides effective and efficient weed management in pigeonpea[10,15,16] and cowpea[7].

Sometimes, farmers miss the application of pre-emergence herbicide and later on find it very difficult to control weeds manually. Under such situations, post-emergence application of herbicides may help in alleviating weed problem. Some of the herbicides may be phytotoxic to pigeonpea at higher rate of application[6,11] or to the succeeding crop[1]. Therefore, the present investigation was undertaken to provide appropriate options to farmers for effective weed management in *kharif* pigeonpea.

MATERIAL AND METHODS

Field experiments was conducted during *kharif* (rainy) season 2013 at RARS, Lam, Guntur (AP) to find out the effect of integrated weed management practices on yield and economics of pigeonpea. The farm is situated at 25°18´ N latitude, 83°36´ E longitude and at an altitude of 128.93 m above mean sea level. The soil of the experimental site was clay loam in texture with soil pH was neutral in reaction (6.2) and an electrical conductivity of 0.22 dSm^{-1}. The soil organic carbon content was low (0.51%). The soil was low in available nitrogen (223 kg ha^{-1}), medium in available phosphorus (23.4 kg ha^{-1}) and available potassium (312 kg ha^{-1}). The total rainfall received during crop growth period was 1060.9 mm in 59 rainy days. Seeds of pigeonpea variety LRG-41 were sown on 14th July, 2013 by dibbling method. Recommended dose of fertilizers 20 kg N and 50 kg P_2O_5 ha^{-1} was applied through urea and single super phosphate (SSP) before dibbling.

The details of the treatments T_1) Pendimethalin @ 0.75 kg ha^{-1} PE + Intercultivation at 50 DAS; T_2) Imazethapyr @100 g *a.i*.ha^{-1} at 10-15 DAS+ Intercultivation at 50 DAS; T_3) Quizalofop ethyl @ 100 g *a.i*.ha^{-1} POE at on 10-15 DAS+ Intercultivation at 50 DAS; T_4) Pendimethalin @ 0.75 kg ha^{-1} PE+ Imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS; T_5) Pendimethalin @ 0.75 kg ha^{-1} PE+ Imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS + Intercultivation at 50 DAS; T_6) Pendimethalin @ 0.75 kg ha^{-1} PE+ Quizalofop ethyl @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS; T_7) Pendimethalin @ 0.75 kg ha^{-1} PE+ Quizalofop ethyl @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS+ Inter cultivation at 50 DAS; T_8) Weed free and T_9) weedy check were tested in randomized block design (RBD). In case of weed free treatment, two hand weedings were taken up at 25 and 50 DAS. In case of pendimethalin treatments, the weedicide was sprayed on the same day after sowing using knapsack sprayer fitted with flood jet nozzle and the spay fluid was 500 litres ha^{-1}. In case of quizalofop ethyl @ 100 g *a.i* ha^{-1} and imazethapyr @100 g *a.i*. ha^{-1} were sprayed as post-emergence application at 10-15 DAS with a spray volume of 500 litres ha^{-1}. Then hand weeding and intercultivation operations were carried out after weedicide application as per treatments.

The crop was grown with standard packages of practice for the region.

Plant height at harvest was recorded for randomly selected five plants. The weed counts were recorded by using quadrant at 70 DAS and kept in hot air oven for recording dry weights. Grain yield data was recorded on whole plot basis and then converted in to kg ha^{-1}. Data on yield components *viz*., branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1} and test weight (100 grain) were also recorded. All data were subjected to analysis of variance (ANOVA) as per standard procedures. Whenever 'F' ratio was found significant, critical difference (CD) value was calculated at p=0.05 to compare the treatment means.

RESULTS AND DISCUSSION

Weeds: The predominant broad leaf weeds found in the experimental plots were such as *Euphorbia hirta, Digera arvensis, Trianthima portulcastrum, Phyllanthus niruri*, grassy weeds such as *Cynodon doctylon*, *Eleusine aegyptiacum* and sedge *Cyperus rotundus*. The experimental findings regarding integrated weed management practices on growth, yield attributes, yield of pigeonpea under *kharif* condition and on weed growth is given in table 1. It was observed that weed intensity (330 m^{-2}) and weed dry weight (49.8g m^{-2}) in weedy check were significantly more as compared to rest of the treatments. The lowest weed counts/intensity and weed dry weights were observed in weed free treatment. The dry matter of weeds in weedy check was maximum because of higher weed intensity and its dominance in utilizing the sunlight, nutrients, moisture, CO_2 *etc*. These results are in conformity with those reported by Murali *et al*.[9] Sukhaidia *et al*.[15], Idapuganti *et al*.[5] and Dhonde *et al*[2].

Application of Pendimethalin @ 0.75 kg ha^{-1} as pre-emergence (PE) controlled all the weed species except *Cyperus rotundus.* Among the herbicide treatments, pre-emergence application of Pendimethalin @ 0.75 kg ha^{-1} and intercultivation at 50 DAS resulted in excellent control of monocots and dicot weeds. Post- emergence (POE) application of either imazethapyr @ 100 g *a.i*.ha^{-1} or quizalofop-ethyl @ 100 g *a.i*.ha^{-1} at 10-15 DAS followed by intercultivation at 50DAS resulted in very good control of both dicot and monocot weeds, respectively. However, integration of intercultivation at 50 DAS either with imazethapyr @ 100 g *a.i*.ha^{-1} POE or quizalofop-ethyl @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS proved more effective in reducing the weed density in comparison to other treatments. The highest weed counts and dry matter were recorded in weedy check plot than other treatments. Post-emergence application of imazethapyr @ 100g *a.i*.ha^{-1} at 10-15 DAS followed by intercultivation at 50 DAS reduced the weed density to the maximum extent which was followed by pre-emergence of pendimethalin @ 0.75 kg *a.i*.ha^{-1} and post-emergence application of imazethapyr @ 100 g *a.i*.ha^{-1} at 10-15 DAS with intercultivation at 50 DAS. This integrated use of herbicide(s) followed by intercultivation at 50 DAS resulted in effective weed control was also reported earlier[2,11,13,16].

Data regarding weed control efficiency (WCE) as influenced by various weed control treatments, revealed that at 70 DAS, the maximum WCE was due to weed free treatment *i.e.* 100 per cent which was significantly superior to those observed in rest of the treatments. Imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS and in integration with intercultivation at 50 DAS resulted in high weed control efficiency (WCE) (86.1%) followed by pendimethalin @ 0.75 kg ha^{-1} PE followed by imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS and intercultivation at 50 DAS (83.9%). This might be due to the efficient control of dicot weeds by intercultivation along with application of herbicides. Similar results of high WCE in urdbean and pigeonpea were also reported by Gupta *et al*.[4] at Jammu and Sharma *et al*.[12] at Kota (Rajasthan), respectively.

Yield attributes and Yield: The maximum plant height (250.7 cm) was recorded in weed free treatment which was significantly superior over weedy check (190.7 cm) and application of pendimethalin @ 0.75 kg ha^{-1} PE or

imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS alone and pendimethalin @ 0.75 kg ha^{-1} PE followed by quizalofop ethyl @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS. However, it was on a par with rest of the treatments. Similarly, more number of branches plant^{-1} (26.3) were registered in the same weed free treatment and it was significantly higher than weedy check (12) and rest of the treatments except pendimethalin @ 0.75 kg ha^{-1} PE followed by imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS (23.5).

The maximum number of pods plant^{-1} (430), test weight (11.6 g) and grain yield (2647 kg ha^{-1}) were also recorded in weed free treatment than weedy check (206.7, 9.2 g and 1477 kg ha^{-1}, respectively). The lowest grain yields (1477 kg ha^{-1}) were recorded with weedy check plot due to appearance of weeds since beginning of crop emergence and resulted in great competition with crop plants for nutrients, moisture and/ sunlight. However, amongst the set of weed management practices, the maximum grain yield was noticed under IWM treatments *viz*., combination of inercultivation at 50 DAS with pendimethalin @ 0.75 kg *a.i*.ha^{-1} PE and imazethapyr @ 100 g *a.i*.ha^{-1} POE (2642 kg ha^{-1}) than integration of intercultivation at 50DAS with pendimethalin @ 0.75kg *a.i*.ha^{-1} (2564 kg ha^{-1}) or imazethapyr @ 100g *a.i*.ha^{-1} (2511 kg ha^{-1}) or application of pendimethalin @ 0.75 kg ha^{-1} PE and quizalofop ethyl @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS (2406 kg ha^{-1}) and the differences between these four treatment combinations were at par with each other as well as with weed free plot. Higher grain yields in these treatments may be due to effective weed control as reflected in lower weed dry matter, higher WCE, better plant growth and yield attributes (Table 1). This variation in weed control could be due to infestation of various weed species and climatic conditions including rainfall distribution pattern. These findings are in concurrence with those of Dhonde *et al*.[2], Idupuganti *et al*.[5], Meena *et al*.[8], Singh and Sakhon[13], and Sharma *et al*[12].

ECONOMICS: Among the weed management practices the maximum gross returns (Rs.132350/-) registered with weed free treatment but the highest net returns (Rs.88555/-) were realized from T_5 (application of Pendimethalin @ 0.75 kg ha^{-1} PE and imazethapyr @ 100 g *a.i*.ha^{-1} POE at 10-15 DAS followed by intercultivation at 50 DAS). The lower B:C ratio registered in weed free (2.01) and treatment T_5 (2.03) was due to higher cost towards manual weeding. Similarly treatment T_1 (application of pendimethalin @ 0.75 kg ha^{-1} PE followed by intercultivation at 50 DAS) (2.09) observed with high B:C ratio compared to other treatments.

Table 1: Growth and yield of Pigeonpea as influenced by different weed control treatments

Treatments	Weed counts (No.m^{-2})	Weed Dry wt. (g m^{-2})	WCE (%)	Plant ht. at harvest (cm)	Branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	100 seed weight (g)
T_1) Pendimethalin 0.75 kg ha^{-1} PE + IC at 50 DAS	49	11.2	77.5	227.3	22.2	381.7	5.9	10.7
T_2) Imazethapyr 100 g *a.i*.ha^{-1} at 10-15 DAS+ IC at 50 DAS	41	6.9	86.1	230.7	21.1	351.7	6.0	10.6
T_3) Quizalofop ethyl 100 g *a.i*.ha^{-1} at 10-15 DAS+ IC at 50 DAS	64	15.8	68.3	235.3	22.8	325.7	6.1	11.0
T_4) Pendimethalin 0.75 kg ha^{-1} PE+ Imazethapyr 100 g *a.i*.ha^{-1} at 10-15 DAS.	77	15.7	68.5	247.3	23.5	370.0	6.1	11.2
T_5) Pendimethalin 0.75 kg ha^{-1} PE+ Imazethapyr 100 g *a.i*.ha^{-1} at 10-15 DAS + IC at 50 DAS	46	8.0	83.9	235.0	20.5	352.3	5.9	10.7
T_6) Pendimethalin 0.75 kg ha^{-1} PE+ Quizalofop ethyl 100 g *a.i*.ha^{-1} at 10-15 DAS	76	9.8	80.3	214.0	20.8	308.0	5.5	9.8
T_7) Pendimethalin 0.75 kg ha^{-1} PE+ Quizalofop ethyl 100 g *a.i*.ha^{-1} at 10-15 DAS + IC at 50 DAS	41	13.3	73.3	247.3	21.6	404.0	6.5	11.5
T_8) weed free	0.0	0.0	-	250.7	26.3	430.0	6.3	11.6
T_9) weedy check	330	49.8	-	190.7	12.0	206.7	5.1	9.2
Sem±	8.0	0.9	-	6.4	1.1	18.4	0.2	0.3
CD (P=0.05)	18.0	2.7	-	19.2	3.2	55.2	0.5	0.9
CV (%)	12.8	10.9	-	4.8	8.7	9.2	4.4	4.7

Table 2: Yield and Economics of Pigeonpea as influenced by different weed control treatments

Treatments	Grain yield (kg ha^{-1})	Gross returns (Rs.ha^{-1})	Cost of cultivation (Rs.ha^{-1})	Net returns (Rs.ha^{-1})	B:C ratio
T_1) Pendimethalin 0.75 kg ha^{-1} PE + IC at 50 DAS	2564	128200	41445	86755	2.09
T_2) Imazethapyr 100 g *a.i*.ha^{-1} at 10-15 DAS+ IC at 50 DAS	2511	125550	41945	83605	1.99
T_3) Quizalofop ethyl 100 g *a.i*.ha^{-1} at 10-15 DAS+ IC at 50 DAS	2344	117200	41945	75255	1.79
T_4) Pendimethalin 0.75 kg ha^{-1} PE+ Imazethapyr 100 g *a.i*.ha^{-1} POE at 10-15 DAS.	2319	115950	42445	73505	1.73
T_5) Pendimethalin 0.75 kg ha^{-1} PE+ Imazethapyr 100 g *a.i*.ha^{-1} POE at 10-15 DAS + IC at 50 DAS	2642	132100	43545	88555	2.03
T_6) Pendimethalin 0.75 kg ha^{-1} PE+ Quizalofop ethyl 100 g *a.i*.ha^{-1} POE at 10-15 DAS	1956	97800	42495	55305	1.30
T_7) Pendimethalin 0.75 kg ha^{-1} PE+ Quizalofop ethyl 100 g *a.i*.ha^{-1} POE at 10-15 DAS + IC at 50 DAS	2406	120300	43445	76855	1.77
T_8) weed free	2647	132350	43445	88405	2.01
T_9) weedy check	1477	73850	38945	34905	0.90
Sem±	105.4				
CD (P=0.05)	315.0				
CV (%)	7.9				

PE: pre-emergence application; POE: post- emergence application at 10-15 DAS and IC: Intercultivation

CONCLUSIONS

From this study, it can be concluded that weed control is a limited factor for realizing higher grain yields in pigeonpea. Apart from the manual weeding, weeds can also be effectively and efficiently controlled with integration of pendimethalin @ 0.75 kg ha^{-1} as PE and imazethapyr as POE at 10-15 DAS followed by intercultivation at 50 DAS which was closely followed by pendimethalin @ 0.75 kg ha^{-1} PE with intercultivation at 50 DAS and imazethapyr POE at 10-15 DAS + intercultivation at 50 DAS, which can result in higher grain yields of pigeonpea.

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